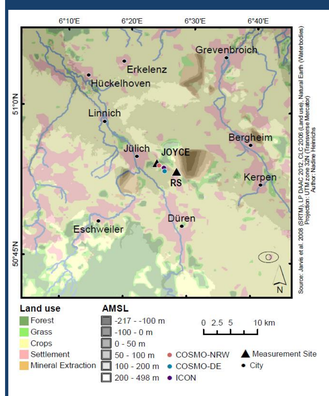
Assessment of integrated water vapor inferred by GPS, miscellaneous measurements and atmospheric models

Steinke[1], S., S. Crewell[1], S. Reitter[1], and G. Dick[2]
[1] Institute of Geophysics and Meteorology, University of Cologne, [2] Geoforschungszentrum Potsdam

Multi-instrument Comparison



The GPS antenna of the Geoforschungszentrum Potsdam (GFZ), a microwave radiometer, and a sunphotometer provide continuous measurements of integrated water vapor (IWV). During HD(CP)² Observational Prototype Experiment (HOPE) in April/May 2013 a large number of radiosoundings is available. These measurements and the infrared and near infrared measurements of MODIS are compared to each other and the model output of ICON.

Results

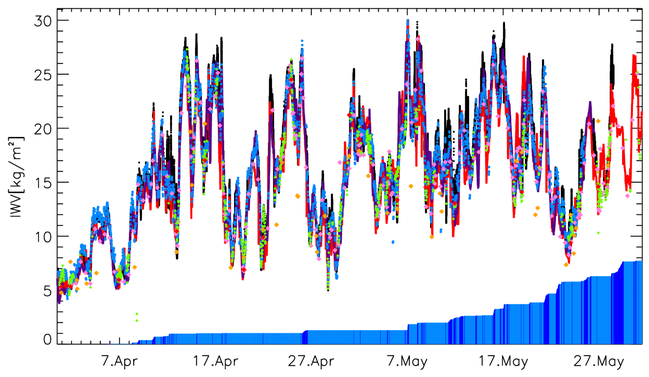


***Fig. 1**: Time series of IWV at JOYCE for April and May 2013. ICON-DE data courtesy of Daniel Klocke, DWD.*

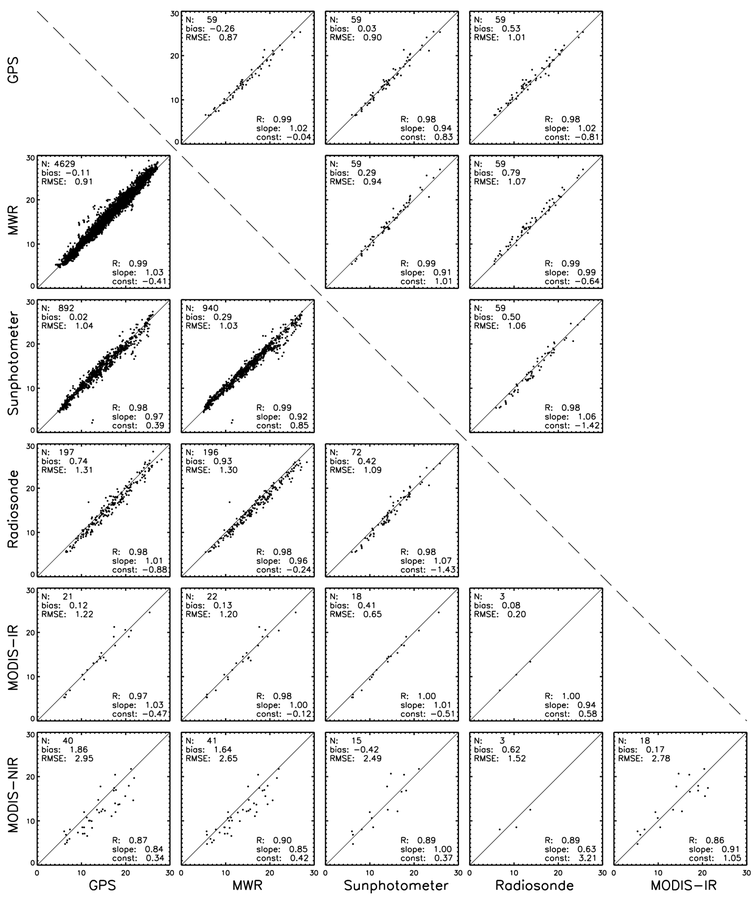


***Fig. 2**: Scatter, bias, RMSE, correlation coefficient, slope, and intercept parameter for all instruments at JOYCE during HOPE in* kg/m²
***Lower-left half**: When the two compared instruments meaasure.*
***Upper-right half**: Only when ALL instruments measure simultaneously.*

Comparison:

- GPS, MWR and sunphotometer agree well with RMSE around 1 mm
- GPS drier than MWR
- radiosondes are drier than GPS (0.7 mm) and MWR (0.9 mm)
- Sunphotometer and MODIS-NIR show low RMSE (0.65 mm) due to same observation principle
- MODIS IR largest bias & RMSE in comparison to other instruments
- Too few data sample for RS – MODIS IR & NIR

Mean daily cycle:

- Well-defined daily cycle in both MWR and GPS
- Offset at beginning/end of day due to varying daily mean
- Larger offset in GPS due to processing

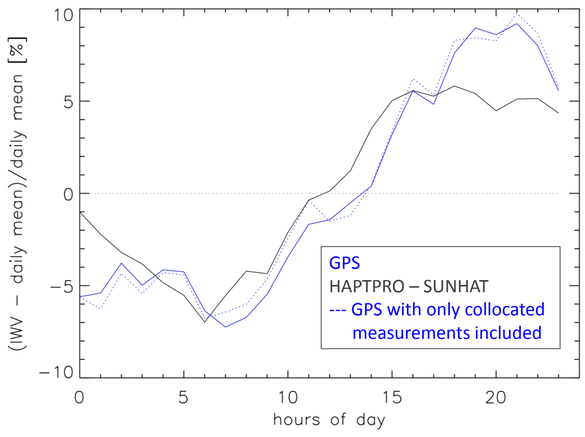


***Fig. 3**: Mean daily IWV cycle from GPS and MWR at JOYCE for April – May 2013.*

Resolved variability:

- Noise level of MWR matches MDS
- Variability in ICON-DE smaller than in COSMO-DE and measurements (due to forcing)
- Variability in COSMO larger than in measurements
- Why mean STD MWR 15 min eventually larger than MWR 5 s?

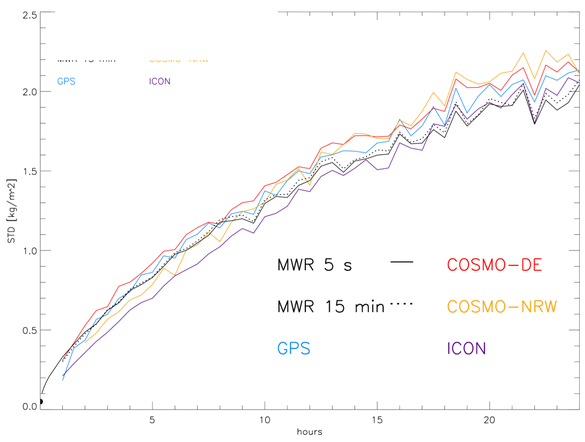
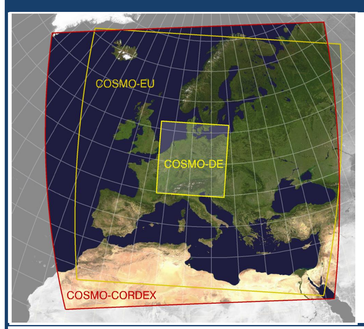


***Fig. 4** : Variation of mean standard deviation with length of time period for April – May 2013. Noise level of MWR given as black dot on y-axis.*

Model Evaluation



The high-resolution COSMO reanalysis (COSMO-REA; dx = 7 km) performed within the Hans Ertel Centre is assessed in terms of water vapor using GPS measurements provided by GFZ relative to ERA-Interim (dx = 50 km) and ERA-Interim downscaling (COSMO-DS).

Results

Comparison of the integrated water vapor (IWV) from measurements by ground stations of the GNSS (Global Navigation Satellite System) network (uncertainty: 1 kg/m²) with simulated IWV from COSMO-REA output every 15 min of the year 2011.

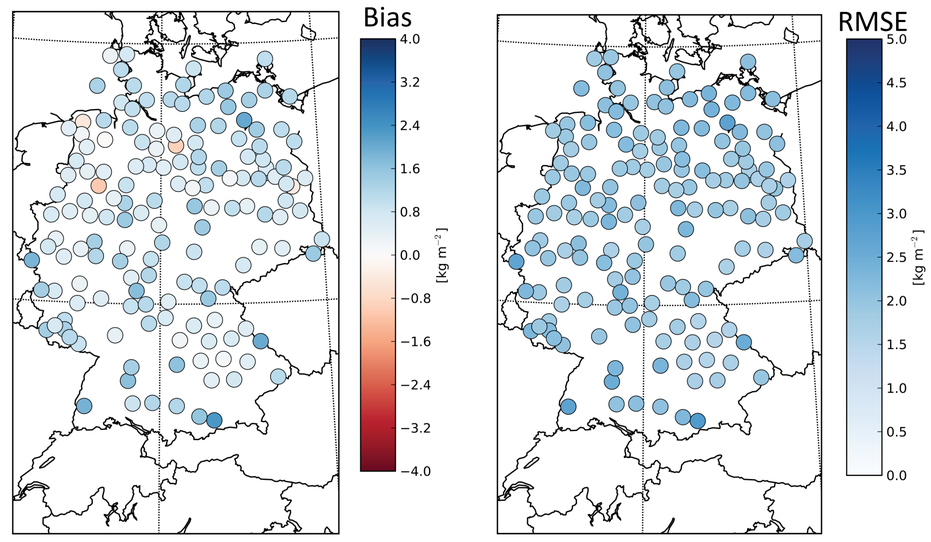


***Fig. 5:** Bias (left) and RMSE (right) between IWV simulated with COSMO-REA and IWV measured by 157 GNSS stations.*

→ In general, COSMO-REA is drier than the GNSS measurements.

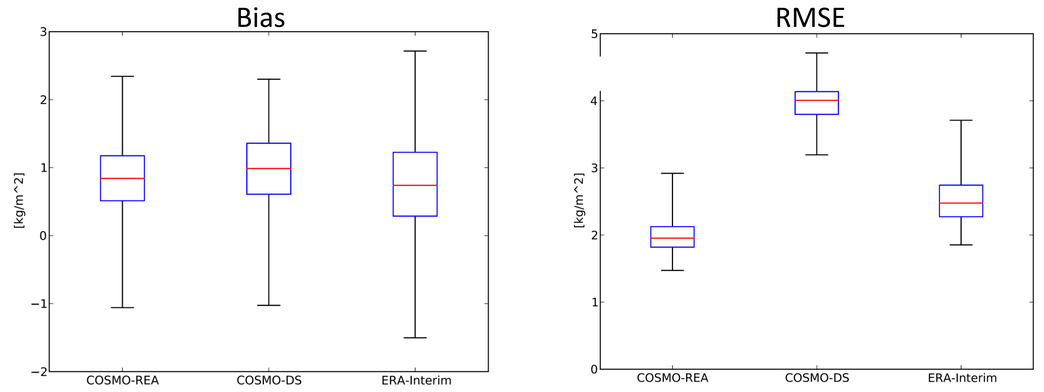
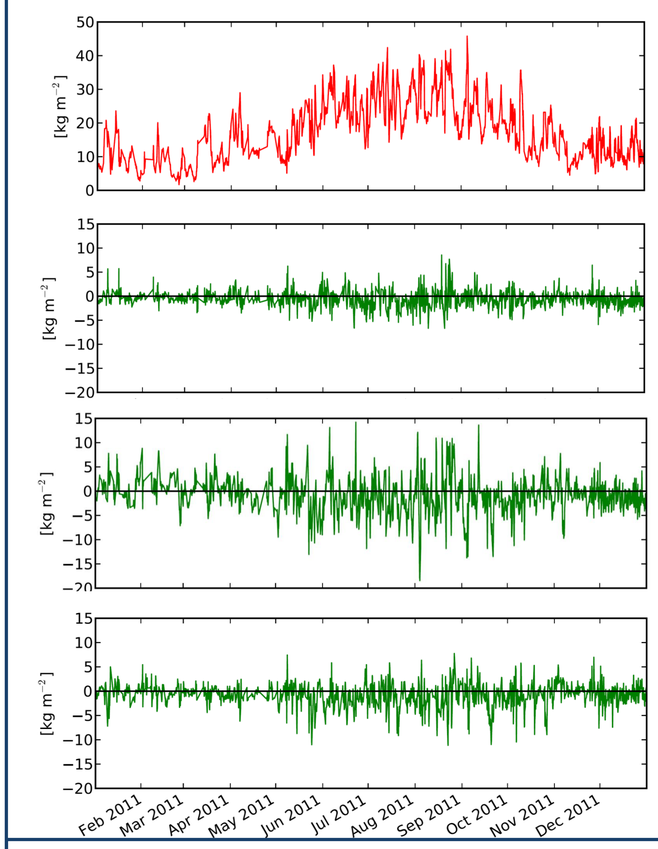


***Fig. 5:** Median, 25% to 75% percentile (Box) and minimum/maximum of bias (left) and RMSE (right) of IWV averaged over all GNSS stations for 2011.*

→ While the bias of each reanalysis is very similar, the RMSE of COSMO-REA is significantly smaller especially than COSMO-DS



→ High temporal variability of IWV is well represented with COMO-REA

***Fig. 7:** Timeseries (Dresden) with a resolution of 3h*
a) IWV measured with GNSS
b) Differences COSMO-REA — measurements
c) Differences COSMO-DS — measurements
d) Differences ERA-interim — measurements

Bollmeyer, C. et al.: "Towards a high resolution regional reanalysis for the CORDEX Europe domain" , Q. J. R. Meteorol. Soc., submitted

Steinke, S. et al.: " Multi-Instrument Comparison of Integrated Water Vapour on High Spatio-Temporal Resolution During HOPE", in preparation